

CLAIMS

- 1 1. A method for measuring the potential of a voltage source in a measured circuit having
2 an impedance in the measured circuit, the method comprising:
 - 3 (a) measuring a first potential by connecting a voltage measuring circuit, having a
4 first input impedance, across the measured circuit and recording the first potential;
 - 5 (b) changing the input impedance of the voltage measuring circuit;
 - 6 (c) measuring a second potential with the voltage measuring circuit connected across
7 the measured circuit, the voltage measuring circuit having the second input
8 impedance and recording the second potential; and
 - 9 (d) solving simultaneous equations, describing the connected measured and voltage
10 measuring circuits, for the potential of the voltage source.
- 1 2. A method in accordance with claim 1 wherein the input impedance is changed by
2 switching a resistive circuit element from one state to a second state, the states being
3 connected in the measuring circuit and disconnected from the measuring circuit.
- 1 3. A method in accordance with claim 1 wherein at least an additional measurement is
2 made for at least one additional input impedance.

1 4. A method in accordance with claim 1 where the simultaneous equations solved are:

$$\left. \begin{aligned} 2 \quad V'_M &= V_A \times \left(\frac{R'_{INPUT}}{R'_{INPUT} + R_{CIRCUIT}} \right) \\ 3 \quad \\ 4 \quad V''_M &= V_A \times \left(\frac{R''_{INPUT}}{R''_{INPUT} + R_{CIRCUIT}} \right) \end{aligned} \right\}$$

5 wherein

6 V'_M is the measured voltage at the first measured impedance

7 V''_M is the measured voltage at the second measured impedance

8 V_A – actual (true) voltage

9 R'_{INPUT} is the first input impedance of the measurement device

10 R''_{INPUT} is the second input impedance of the measurement device

11 $R_{CIRCUIT}$ – resistance of the measured circuit

1 5. A method in accordance with claim 4 wherein the input impedance is changed by
2 switching a resistive circuit element from one state to a second state, the states being
3 connected in the measuring circuit and disconnected from the measuring circuit.

1 6. A method in accordance with claims 1 or 2 or 3 or 4 or 5 wherein the circuit being
2 measured includes a metal object buried in soil and a reference electrode in contact with
3 the soil and wherein the voltage measuring circuit is electrically connected between the
4 metal object and the reference electrode.

- 1 7. An apparatus for measuring the potential of a voltage source in a measured circuit
2 having an impedance in the measured circuit, the apparatus comprising:
3 (a) a voltage measuring circuit having an input impedance;
4 (b) a switchable impedance network in the voltage measuring circuit for varying the
5 input impedance to a plurality of input impedance values;
6 (c) a microcontroller connected to the voltage measuring circuit for switching the
7 input impedance, for recording measured potentials at a plurality of input
8 impedances, for solving simultaneous equations, the equations describing the
9 connected measured and voltage measuring circuits, for the potential of the
10 voltage source, and for outputting a signal representing the potential of the
11 voltage source.
- 1 8. An apparatus in accordance with claim 7 wherein the switchable impedance network
2 comprises a plurality of resistors at least one of the resistors being connected to a switch
3 for switching said one resistor alternatively in and out of the circuit.
- 1 9. An apparatus in accordance with claim 8 wherein the switchable impedance network
2 comprises a plurality of resistors, each resistor connected to a switch and being
3 alternatively switchable into the circuit.

1 10. An apparatus in accordance with claim 7 or 8 or 9 wherein the microcontroller is
 2 programmed to solve equations which are substantially:

$$\begin{aligned}
 &V'_M = V_A \times \left(\frac{R'_{INPUT}}{R'_{INPUT} + R_{CIRCUIT}} \right) \\
 &V''_M = V_A \times \left(\frac{R''_{INPUT}}{R''_{INPUT} + R_{CIRCUIT}} \right)
 \end{aligned}$$

6 wherein

7 V'_M is the measured voltage at the first measured impedance

8 V''_M is the measured voltage at the second measured impedance

9 V_A – actual (true) voltage

10 R'_{INPUT} is the first input impedance of the measurement device

11 R''_{INPUT} is the second input impedance of the measurement device

12 $R_{CIRCUIT}$ – resistance of the measured circuit